

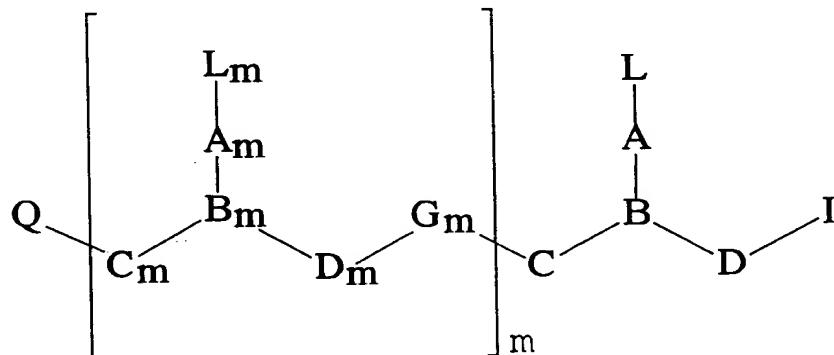
## WHAT IS CLAIMED IS:

1. A peptide nucleic acid conjugate comprising:
  - a peptide nucleic acid;
  - said peptide nucleic acid having a backbone;
  - 5 said backbone having an amino end, a carboxyl end, and a plurality of amino groups;
  - said amino groups each having a tethered nucleobase; and a conjugate bound to said peptide nucleic acid either directly or through a linking moiety.
- 10 2. A peptide nucleic acid conjugate of claim 1 wherein said conjugate is bound through said linking moiety to at least one of said backbone, said tether, or said nucleobase.
- 15 3. A peptide nucleic acid conjugate of claim 1 wherein said conjugate is bound to said backbone.
4. A peptide nucleic acid conjugate of claim 3 wherein said conjugate is bound to at least one of said amino end or said carboxyl end of said backbone.
- 20 5. A peptide nucleic acid conjugate of claim 1 wherein said conjugate is bound to said nucleobase or said tether.

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6. A peptide nucleic acid conjugate of claim 1  
 wherein said conjugate is a reporter enzyme, a reporter  
 molecule, a steroid, a carbohydrate, a terpene, a peptide, a  
 protein, an aromatic lipophilic molecule, a non aromatic  
 5 lipophilic molecule, a phospholipid, an intercalator, a cell  
 receptor binding molecule, a crosslinking agent, a water  
 soluble vitamin, a lipid soluble vitamin, an RNA/DNA  
 cleaving complex, a metal chelator, a porphyrin, an  
 alkylator, or a polymeric compound selected from polymeric  
 10 amines, polymeric glycols and polyethers.

A) A peptide nucleic acid conjugate of the formula:



wherein:

B

m is an <sup>integer</sup> from 1 to about 50;

L and L<sub>m</sub> independently are R<sup>12</sup>(R<sup>13</sup>)<sub>a</sub>; wherein:

15

R<sup>12</sup> is hydrogen, hydroxy, (C<sub>1</sub>-C<sub>4</sub>) alkanoyl, a

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naturally occurring nucleobase, a non-naturally occurring nucleobase, an aromatic moiety, a DNA intercalator, a nucleobase-binding group, a heterocyclic moiety, a reporter ligand, or a conjugate;

5

provided that at least one of R<sup>12</sup> is a naturally occurring nucleobase, a non-naturally occurring nucleobase, a DNA intercalator, or a nucleobase-binding group;

10

R<sup>13</sup> is a conjugate; and  
a is 0 or 1;

C and C<sub>m</sub> independently are (CR<sup>6</sup>R<sup>7</sup>)<sub>y</sub>; wherein:

15

R<sup>6</sup> and R<sup>7</sup> independently are hydrogen, a side chain of a naturally occurring alpha amino acid, (C<sub>2</sub>-C<sub>6</sub>) alkyl, aryl, aralkyl, heteroaryl, hydroxy, (C<sub>1</sub>-C<sub>6</sub>) alkoxy, (C<sub>1</sub>-C<sub>6</sub>) alkylthio, a conjugate, NR<sup>3</sup>R<sup>4</sup>, SR<sup>5</sup> or R<sup>6</sup> and R<sup>7</sup> taken together complete an alicyclic or heterocyclic system;

20

wherein R<sup>5</sup> is hydrogen, a conjugate, (C<sub>1</sub>-C<sub>6</sub>) alkyl, hydroxy-, alkoxy-, or alkylthio-substituted (C<sub>1</sub>-C<sub>6</sub>) alkyl; and

25

R<sup>3</sup> and R<sup>4</sup> independently are hydrogen, a conjugate, (C<sub>1</sub>-C<sub>4</sub>) alkyl, hydroxy- or alkoxy- or alkylthio-substituted (C<sub>1</sub>-C<sub>4</sub>) alkyl, hydroxy, alkoxy, alkylthio or amino;

D and D<sub>m</sub> independently are (CR<sup>6</sup>R<sup>7</sup>)<sub>z</sub>;

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each of y and z is zero or an integer from 1 to 10,  
 wherein the sum y + z is greater than 2 but not more than  
 10;

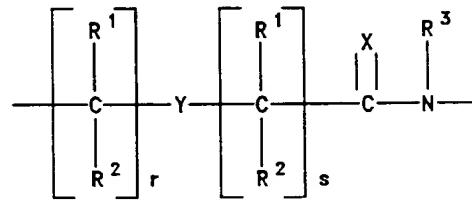
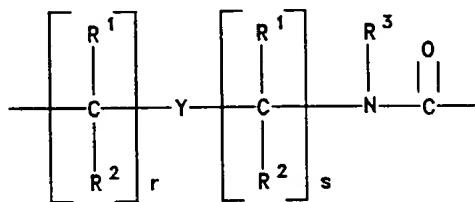
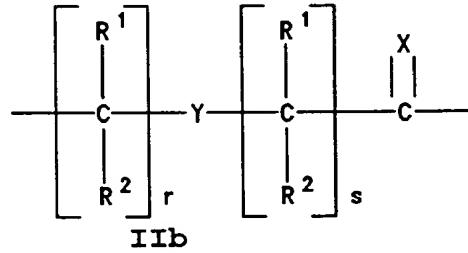
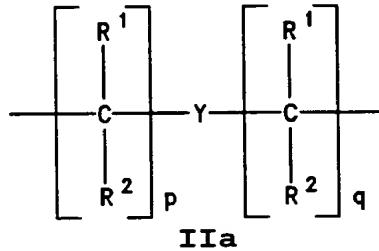
$G_m$  is independently  $-NR^3CO-$ ,  $-NR^3CS-$ ,  $-NR^3SO-$ , or  
 5  $-NR^3SO_2-$  in either orientation;

each pair of  $A-A_m$  and  $B-B_m$  are selected such that:

(a)  $A$  or  $A_m$  is a group of formula (IIa), (IIb) or  
 (IIc) and  $B$  or  $B_m$  is N or  $R^3N^+$ ; or

(b)  $A$  or  $A_m$  is a group of formula (IId) and  $B$  or  $B_m$  is

10 CH;



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wherein:

X is O, S, Se, NR<sup>3</sup>, CH<sub>2</sub> or C(CH<sub>3</sub>)<sub>2</sub>;

Y is a single bond, O, S or NR<sup>4</sup>;

each of p and q is zero or an integer from 1 to 5, ~~the~~

5 sum p+q being not more than 10;

each of r and s is zero or an integer from 1 to 5, ~~the~~  
~~sum r+s being not more than 10,~~

R<sup>1</sup> and R<sup>2</sup> independently are hydrogen, (C<sub>1</sub>-C<sub>4</sub>)alkyl,  
hydroxy-substituted (C<sub>1</sub>-C<sub>4</sub>)alkyl, alkoxy-substituted (C<sub>1</sub>-  
10 C<sub>4</sub>)alkyl, alkylthio-substituted (C<sub>1</sub>-C<sub>4</sub>)alkyl, hydroxy,  
alkoxy, alkylthio, amino, halogen or a conjugate;

I is -NR<sup>8</sup>R<sup>9</sup> or -NR<sup>10</sup>C(O)R<sup>11</sup>; wherein:

R<sup>8</sup>, R<sup>9</sup>, R<sup>10</sup> and R<sup>11</sup> independently are hydrogen,  
alkyl, an amino protecting group, a reporter

15 ligand, an intercalator, a chelator, a peptide, a  
protein, a carbohydrate, a lipid, a steroid, a  
nucleoside, a nucleotide, a nucleotide  
diphosphate, a nucleotide triphosphate, an  
oligonucleotide, an oligonucleoside, a soluble  
20 polymer, a non-soluble polymer or a conjugate;

Q is -CO<sub>2</sub>H, -CO<sub>2</sub>R<sup>8</sup>, -CO<sub>2</sub>R<sup>9</sup>, -CONR<sup>8</sup>R<sup>9</sup>, -SO<sub>3</sub>H, -SO<sub>2</sub>NR<sup>10</sup>R<sup>11</sup> or  
an activated derivative of -CO<sub>2</sub>H or -SO<sub>3</sub>H; and

wherein at least one of R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup>, R<sup>5</sup>, R<sup>6</sup>, R<sup>7</sup>, R<sup>8</sup>,  
R<sup>9</sup>, R<sup>10</sup>, R<sup>11</sup>, R<sup>12</sup> and R<sup>13</sup> is a conjugate wherein said conjugate  
25 is a reporter enzyme, a reporter molecule, a steroid, a

carbohydrate, a terpene, a peptide, a protein, an aromatic lipophilic molecule, a non aromatic lipophilic molecule, a phospholipid, an intercalator, a cell receptor binding molecule, a crosslinking agent, a water soluble vitamin, a 5 lipid soluble vitamin, an RNA/DNA cleaving complex, a metal chelator, a porphyrin an alkylator, or a polymeric compound selected from polymeric amines, a polymeric glycols and polyethers; and

wherein said conjugate optionally includes a linking 10 moiety.

2  
8. A peptide nucleic acid conjugate of claim 7  
wherein said conjugate includes a linking moiety.

3  
9. A peptide nucleic acid conjugate of claim 8  
wherein at least one group R<sup>12</sup> is a conjugate.

4  
10. A peptide nucleic acid conjugate of claim 9  
wherein at least one group R<sup>13</sup> is a conjugate.

5  
11. A peptide nucleic acid conjugate of claim 10  
wherein at least one of R<sup>1</sup>, R<sup>2</sup> or R<sup>3</sup> is a conjugate.

6  
12. A peptide nucleic acid conjugate of claim 11  
20 wherein at least one of said A-A<sub>m</sub> groups include at least one of R<sup>1</sup>, R<sup>2</sup>, and R<sup>3</sup>.

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13. A peptide nucleic acid conjugate of claim ~~11~~<sup>5</sup>  
wherein at least one of said B-B<sub>m</sub> groups or said G-G<sub>m</sub> groups  
include at least one group R<sup>3</sup>.

14. A peptide nucleic acid conjugate of claim ~~7~~<sup>1</sup>  
5 wherein at least one of R<sup>8</sup>, R<sup>9</sup>, R<sup>10</sup> and R<sup>11</sup> is a conjugate.

15. A peptide nucleic acid conjugate of claim ~~14~~<sup>8</sup>  
wherein at least one of said groups Q or I include at least  
one of groups R<sup>8</sup>, R<sup>9</sup>, R<sup>10</sup> and R<sup>11</sup>.

16. A peptide nucleic acid conjugate of claim ~~7~~<sup>1</sup>  
10 wherein at least one of R<sup>3</sup>, R<sup>4</sup>, R<sup>5</sup>, R<sup>6</sup> and R<sup>7</sup> is a conjugate.

17. A peptide nucleic acid conjugate of claim ~~16~~<sup>10</sup>  
wherein at least one of said groups D-D<sub>m</sub>, or C-C<sub>m</sub> include at  
least one of R<sup>3</sup>, R<sup>4</sup>, R<sup>5</sup>, R<sup>6</sup> and R<sup>7</sup>.

18. A peptide nucleic acid conjugate of claim ~~7~~<sup>1</sup>  
15 wherein m is from 1 to about 200.

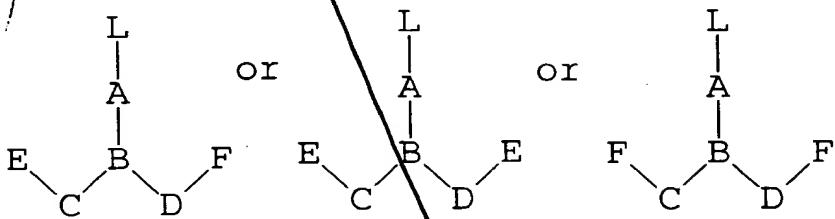
19. A peptide nucleic acid conjugate of claim ~~7~~<sup>1</sup>  
wherein m is from 1 to about 50.

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~~14~~ 20. A peptide nucleic acid conjugate of claim ~~1~~  
wherein m is from 1 to about 20.

~~21.~~ 21. A compound having one of the following formulas:



wherein:

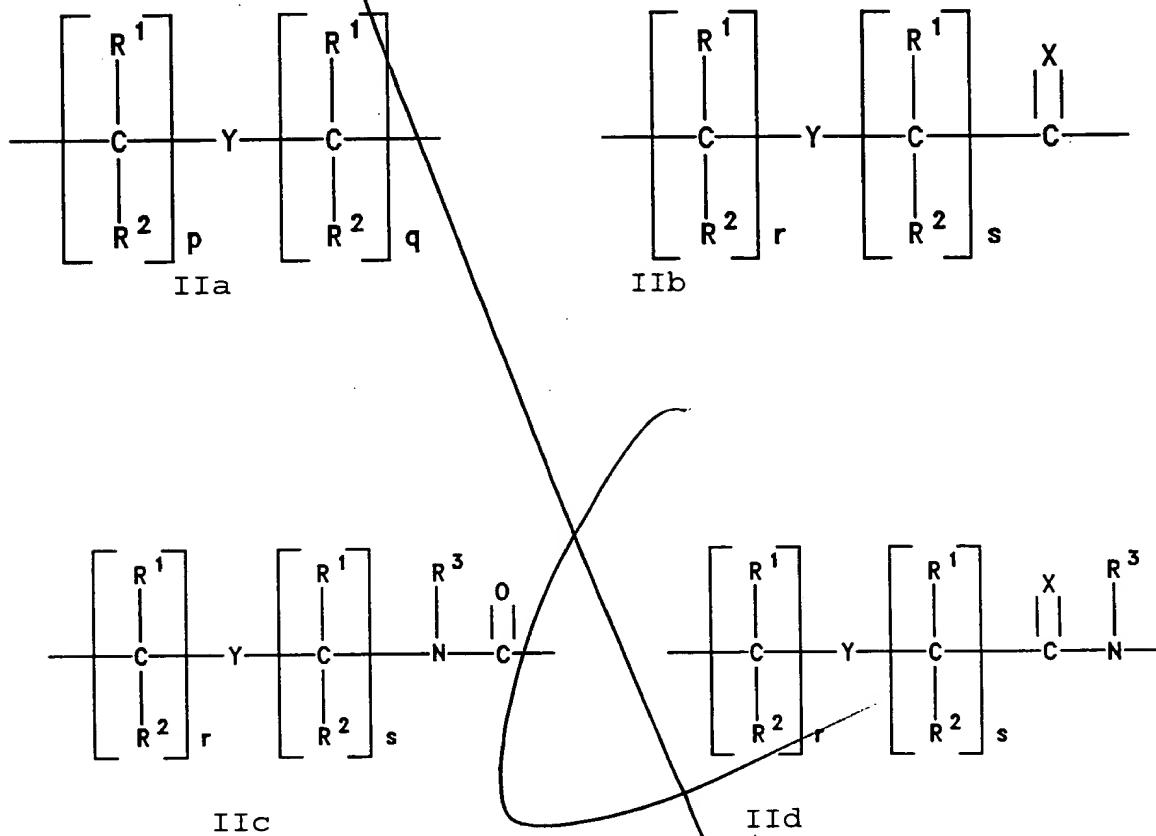
5 L is  $R^{12}(R^{13})_a$ ; wherein:

$R^{12}$  is hydrogen, hydroxy, ( $C_1-C_4$ ) alkanoyl, a naturally occurring nucleobase, a non-naturally occurring nucleobase, an aromatic moiety, a DNA intercalator, a nucleobase-binding group, a heterocyclic moiety, a reporter ligand, or a conjugate and at least one of  $R^{12}$  is a naturally occurring nucleobase, a non-naturally occurring nucleobase, a DNA intercalator, or a nucleobase-binding group;

10 15  $R^{13}$  is a conjugate; and  
a is 0 or 1;

A and B are selected such that:

(a) A is a group of formula (IIa), (IIb) or (IIc) and B is N or  $R^3N^+$ ; or  
 (b) A is a group of formula (IId) and B is CH;



5 where:

X is O, S, Se,  $NR^3$ ,  $CH_2$  or  $C(CH_3)_2$ ;

Y is a single bond, O, S or  $NR^4$ ;

p and q independently are zero or an integer from 1 to 5, ~~the sum p+q being not more than 10,~~

10 r and s independently are zero or an integer from 1 to 5, ~~the sum r+s being not more than 10,~~

$R^1$  and  $R^2$  independently are hydrogen,  $(C_1-C_4)$  alkyl,

hydroxy-substituted ( $C_1-C_4$ )alkyl, alkoxy-substituted ( $C_1-C_4$ )alkyl, alkylthio-substituted ( $C_1-C_4$ )alkyl, hydroxy, alkoxy, alkylthio, amino, halogen or a conjugate;

C is  $(CR^6R^7)_y$ ;

5 D is  $(CR^6R^7)_z$ ; wherein:

R<sup>6</sup> and R<sup>7</sup> independently are hydrogen, a side chain of a naturally occurring alpha amino acid, ( $C_2-C_6$ ) alkyl, aryl, aralkyl, heteroaryl, hydroxy, ( $C_1-C_6$ ) alkoxy, ( $C_1-C_6$ ) alkylthio, a conjugate, NR<sup>3</sup>R<sup>4</sup> and SR<sup>5</sup> or R<sup>6</sup> and R<sup>7</sup> taken together complete an

10 alicyclic or heterocyclic system;

R<sup>3</sup> and R<sup>4</sup> independently are hydrogen, a conjugate, ( $C_1-C_4$ )alkyl, hydroxy- or alkoxy- or alkylthio- substituted ( $C_1-C_4$ )alkyl, hydroxy, alkoxy,

15 alkylthio or amino; and

R<sup>5</sup> is hydrogen, a conjugate, ( $C_1-C_6$ )alkyl, hydroxy-, alkoxy-, or alkylthio- substituted ( $C_1-C_6$ )alkyl; each of y and z is zero or an integer from 1 to 10, the sum y + z being greater than 2 but not more than 10;

20 E independently is COOH, CSOH, SOOH, SO<sub>2</sub>OH or an activated or protected derivative thereof;

F independently is NHR<sup>3</sup> or NPgR<sup>3</sup>, where Pg is an amino protecting group; and

25 at least one of R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup>, R<sup>5</sup>, R<sup>6</sup>, R<sup>7</sup>, R<sup>12</sup>, and R<sup>13</sup> is a conjugate wherein said conjugate is a reporter enzyme, a reporter molecule, a steroid, a carbohydrate, a terpene, a peptide, a protein, an aromatic lipophilic molecule, a non aromatic lipophilic molecule, a phospholipid, an intercalator, a cell receptor binding molecule, a crosslinking agent, a water soluble vitamin, a lipid soluble vitamin, an RNA/DNA cleaving complex, a metal chelator, a porphyrin an alkylator, or a polymeric compound selected from polymeric amines, polymeric glycals and polyethers; and wherein said conjugate optionally includes a linking moiety.

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16 22. A peptide nucleic acid conjugate of claim ~~21~~<sup>15</sup>  
wherein said conjugate includes a linking moiety.

17 23. A peptide nucleic acid conjugate of claim ~~21~~<sup>21</sup>  
wherein R<sup>12</sup> is a conjugate.

5 24. A peptide nucleic acid conjugate of claim ~~21~~<sup>21</sup>  
wherein R<sup>13</sup> is a conjugate.

18 25. A peptide nucleic acid conjugate of claim ~~21~~<sup>21</sup>  
wherein at least one group R<sup>3</sup> is a conjugate.

10 26. A peptide nucleic acid conjugate of claim ~~21~~<sup>21</sup>  
wherein at least one of said groups A or said groups B  
include a conjugate.

26 27. A peptide nucleic acid conjugate of claim ~~21~~<sup>21</sup>  
wherein at least one of group R<sup>1</sup> or group R<sup>2</sup> is a conjugate.

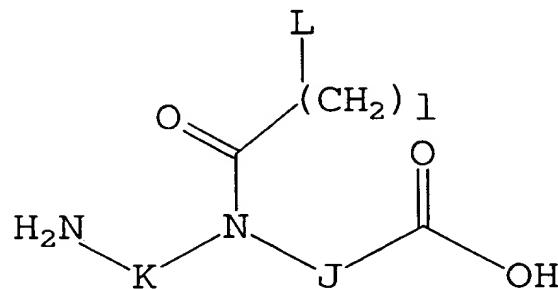
15 28. A peptide nucleic acid conjugate of claim ~~21~~<sup>21</sup>  
wherein at least one of R<sup>3</sup>, R<sup>4</sup>, R<sup>5</sup>, R<sup>6</sup>, and R<sup>7</sup> is a conjugate.

22 29. A peptide nucleic acid conjugate of claim ~~21~~<sup>21</sup>  
wherein at least one of said groups C or said groups D  
include a conjugate.

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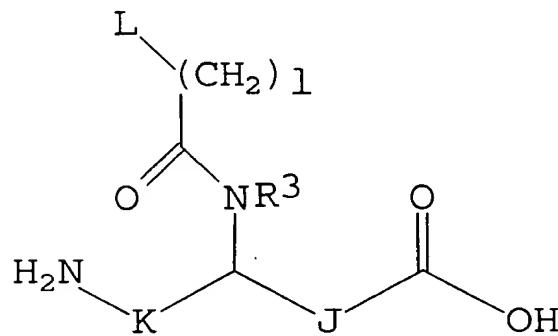
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~~30~~ A peptide nucleic acid conjugate comprising a plurality of PNA monomers wherein at least one of said PNA monomers has the formula:

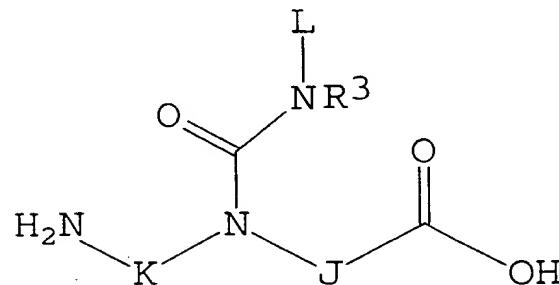


*2330*  
or formula:

5



or formula:



*233*

wherein:

L is  $R^{12}(R^{13})_a$ ; wherein:

5             $R^{12}$  is hydrogen, hydroxy, ( $C_1-C_4$ ) alkanoyl, a naturally occurring nucleobase, a non-naturally occurring nucleobase, an aromatic moiety, a DNA intercalator, a nucleobase-binding group, a heterocyclic moiety, a reporter ligand, or a conjugate and at least one of  $R^{12}$  is a naturally occurring nucleobase, a non-naturally occurring nucleobase, a DNA intercalator, or a nucleobase-

10            binding group;

$R^{13}$  is a conjugate; and

              a is 0 or 1;

K is  $(CR^6R^7)_z$ ;

15            J is  $(CR^6R^7)_y$ ; wherein:

$R^6$  and  $R^7$  are independently hydrogen, a side chain of a naturally occurring alpha amino acid, ( $C_2-C_6$ ) alkyl, aryl, aralkyl, heteroaryl, hydroxy, ( $C_1-C_6$ ) alkoxy, ( $C_1-C_6$ ) alkylthio, a conjugate,  $NR^3R^4$  and  $SR^5$  or  $R^6$  and  $R^7$  taken together complete an alicyclic or heterocyclic system;

20             $R^3$  and  $R^4$  independently are hydrogen, a conjugate, ( $C_1-C_4$ ) alkyl, hydroxy- or alkoxy- or alkylthio-substituted ( $C_1-C_4$ ) alkyl, hydroxy, alkoxy,

25            alkylthio or amino;

$R^5$  is hydrogen, a conjugate, ( $C_1-C_6$ ) alkyl, hydroxy-, alkoxy-, or alkylthio- substituted ( $C_1-C_6$ ) alkyl;

              each of y and z is zero or an integer from 1 to 10, the sum y + z being greater than 2 but not more than 10;

30            l is an integer from 1 to 5; and

              at least one of  $R^1$ ,  $R^2$ ,  $R^3$ ,  $R^4$ ,  $R^5$ ,  $R^6$ ,  $R^7$ ,  $R^{12}$ , and  $R^{13}$  is a conjugate wherein said conjugate is a reporter enzyme, a reporter molecule, a steroid, a carbohydrate, a terpene, a peptide, a protein, an aromatic lipophilic molecule, a non aromatic lipophilic molecule, a phospholipid, an

intercalator, a cell receptor binding molecule, a crosslinking agent, a water soluble vitamin, a lipid soluble vitamin, an RNA/DNA cleaving complex, a metal chelator, a porphyrin an alkylator, or a polymeric compound selected 5 from polymeric amines, polymeric glycols and polyethers; and wherein said conjugate optionally includes a linking moiety.

24  
21. A peptide nucleic acid conjugate of claim ~~30~~<sup>23</sup> wherein said conjugate includes a linking moiety.

25  
10 22. A peptide nucleic acid conjugate of claim ~~30~~<sup>23</sup> wherein R<sup>12</sup> is a conjugate.

26  
23. A peptide nucleic acid conjugate of claim ~~30~~<sup>23</sup> wherein R<sup>13</sup> is a conjugate.

27  
15 24. A peptide nucleic acid conjugate of claim ~~30~~<sup>23</sup> wherein at least one of R<sup>3</sup>, R<sup>4</sup>, R<sup>5</sup>, R<sup>6</sup>, and R<sup>7</sup> is a conjugate.

28  
25. A peptide nucleic acid conjugate of claim ~~30~~<sup>23</sup> wherein at least one of said group K or said group J includes a conjugate.

29  
26. A peptide nucleic acid conjugate of claim ~~30~~<sup>23</sup> 20 wherein said group R<sup>3</sup> is a conjugate.

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